Missouri Department of Natural Resources

Biological Assessment Report

Fishing River Watershed
Clay & Ray Counties

January 27, 2004

Prepared for:

Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Protection Program

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1.0 Introduction

On approval from the Water Protection Program (**WPP**), the Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of the Fishing River watershed, which flows through rural and urban portions of Clinton, Clay, and Ray counties, Missouri. This assessment was designed to be part of a joint study conducted by the WQMS and the Missouri Department of Conservation (**MDC**) for Region 7 of the United States Environmental Protection Agency (**EPA**). The objectives of this project were to: 1) determine whether there is greater aquatic life impairment in the most downstream portions of Fishing River relative to sections upstream that are isolated from tributaries that serve as receiving systems for permitted point-source facilities; 2) rank macroinvertebrate community metric scores from each of the major tributaries and compare the rankings to the level of human disturbance in each Fishing River major subwatershed; 3) establish a baseline to document the condition of the aquatic fauna as it currently exists as point of comparison for future studies; and 4) supplement fish community information gathered by MDC personnel in this watershed.

Macroinvertebrate and water quality sampling was conducted from March 25 through April 3, 2003 to provide data to the WPP for use in evaluating the Fishing River watershed. Dave Michaelson and Cecilia Campbell of the Environmental Services Program, Air and Land Protection Division conducted the sampling. In addition, MDC biologists Todd Gemeinhardt, Mark Griddine, and Jason Bennett assisted in sampling and provided landowner contacts at all sample sites.

On February 11, 2003 a study plan was submitted to the WPCP (Appendix A). A total of three null hypotheses were stated in this plan:

1) Macroinvertebrate assemblages will not differ among longitudinally separate reaches of Fishing River, separated relative to tributary influence.

2) Measures of habitat quality will not differ among longitudinally separate reaches of Fishing River.

3) The rankings of biological metrics and levels of human disturbance will not differ among the Fishing River sub-watersheds.

2.0 Study Area

2.1 Fishing River

The mainstem of Fishing River originates in western Clay County, north of Liberty, and flows in an overall southeasterly direction to its confluence with the Missouri River near Orrick. Overall, the Fishing River watershed is mostly rural, dominated by pasture, cropland, and forested areas.

See Table 1 for a comparison of land use for Fishing River, each of its tributaries, and three sites from western Missouri reference streams. Although much of the watershed remains rural, Clay County is experiencing continuing growth associated with urban sprawl emanating from Kansas City.

Table 1
Percent Land Cover

	Urban	Crops	Grassland	Forest	Swamp/ Marsh
PMBL EDU*	2.2	41.1	38.2	16.3	0.2
Fishing River**	0.7	25.2	57.5	15.5	0.08
Clear Creek	0.7	22.3	61.2	15.7	0.007
Upper Clear Creek***	0.3	25.1	56.7	17.6	0.011
Muddy Fork	0.04	19.5	62.7	16.7	0.005
Carroll Creek	0.0	18.4	63.1	18.1	0.008
Williams Creek	1.3	15.9	61.5	20.0	0.0
EF Fishing River	1.6	16.9	52.9	27.4	0.005
Holmes Creek	0.1	13.3	79.9	6.2	0.014
Little Drywood #1	0.2	16.2	62.4	20.0	0.0
Little Drywood #2	0.0	19.1	60.9	18.8	0.0
EF Crooked River	0.1	67.1	22.3	8.5	0.0

*Plains/Missouri Tributaries between the Blue and Lamine Rivers
**Includes entire watershed--i.e., Fishing River and each of its sub-watersheds
***Upstream of the Muddy Fork Confluence

U.S. Census data indicate that Clay County's population has grown 20 percent since 1990; as populations continue to increase in the county and in towns such as Liberty, Excelsior Springs, and Kearney, water quality and habitat decline associated with increased development may be occurring in this watershed. The degree to which these impacts occur in the Fishing River watershed is unknown and has prompted this joint study between the Missouri Department of Natural Resources (**DNR**) and MDC.

The Fishing River watershed encompasses approximately 288 square miles and is fed by six major tributaries: Clear Creek, Muddy Fork, Carroll Creek, Williams Creek, Holmes Creek, and East Fork Fishing River.

Fishing River and each of its tributaries are located in the Plains/Missouri tributaries between the Blue and Lamine (**PMBL**) Ecological Drainage Unit (**EDU**). An EDU is a region in which biological communities and habitat conditions can be expected to be similar. Please see Appendix B for maps of the EDU and the 11-digit Hydrologic Unit (**HU**), 10300101060. Fishing River sample stations 1 through 3 fall in a reach designated class "P" with beneficial use designations of "irrigation," "livestock and wildlife watering," (**LWW**) and "protection of warm water aquatic life and human health—fish consumption" (**AQL**). Fishing River sample station 4 falls in a reach of the stream designated class "C" with the same beneficial use designations

listed above, with the exception that "irrigation" is not included. Each of the remaining study sites in the Fishing River tributaries fell within reaches designated class "C" with beneficial use designations of LWW and AQL.

2.2 Fishing River Major Tributaries

Clear Creek
Clear Creek originates in south central Clinton County, southwest of Lathrop. It flows south-southeast through a watershed approximately 89 square miles in area (the largest Fishing River sub-watershed) which is dominated by pastureland, row crops, and forest. It enters Fishing River near the town of Mosby in southeastern Clay County. The Clear Creek watershed includes the sub-watersheds of Muddy Fork and Carroll Creek and lies within HU #10300101060002. Clear Creek Station 1 is within a reach designated class "P" with LWW and AQL as beneficial use designations. Clear Creek Stations 2 and 3 were in reaches designated class "C" also with LWW and AQL as beneficial use designations. Although Station 2 could not be sampled due to lack of water, Station 3, which was located approximately 5.9 miles upstream from Station 2, had sufficient water levels to collect macroinvertebrates from all available habitat types.

Muddy Fork
Muddy Fork originates in southeastern Clinton County, southeast of Lathrop. It flows south into Lake Arrowhead, which is surrounded by a subdivision. At the outfall of the reservoir, Muddy Fork resumes its course and enters Clear Creek northeast of Kearney. The Muddy Fork watershed is approximately 33 square miles in area; the dominant land uses within the watershed are pastureland, row crops, and forest. Both Muddy Fork sample stations lie within reaches designated class "C" with LWW and AQL listed as beneficial use designations.

Carroll Creek
Carroll Creek originates in northeastern Clay County, west of Lawson and north of Watkins Mill State Park. It flows in a southerly direction and enters Clear Creek southeast of Kearney. The Carroll Creek watershed is approximately 14 square miles in area and has the distinction of being the only sub-watershed within the Fishing River drainage without a permitted point source discharge. The dominant land uses within the watershed are pastureland, row crops, and forest. Both Carroll Creek sites are in reaches designated class "C" with LWW and AQL listed as beneficial uses.

Williams Creek
Williams Creek originates in northeastern Clay County, southwest of Lawson and north of Watkins Mill State Park in HU# 10300101060003. It flows in a southerly direction and enters Fishing River southeast of Mosby. An upper branch of Williams Creek has been impounded to create Watkins Mill Lake, which is on the proposed 2002 303(d) list for fecal coliform from an unknown source. The Williams Creek watershed is approximately 22 square miles in area; the dominant land uses are pastureland, row crops, and forest, but also has a higher percentage of urban surface area (1.3%) compared to other sub-watersheds within the Fishing River drainage. Both Williams Creek sites are in reaches designated class "C" with LWW and AQL listed as beneficial uses.

East Fork Fishing River
East Fork Fishing River originates in northwestern Ray County near the town of Lawson in HU# 10300101060005. It flows south into Crystal Lake, which is surrounded by a subdivision and frequently has water quality problems in the form of low dissolved oxygen and fish kills (Steve Fischer, MDC Fisheries Biologist, pers. comm.). At the outfall of the reservoir, the river resumes a southerly course flowing through Excelsior Springs before joining Fishing River northeast of Missouri City. The East Fork Fishing River watershed is approximately 31 square miles in area and although the dominant land uses are pastureland, row crops, and forest, this sub-watershed has the highest percentage of urban surface area (1.6%) within the Fishing River drainage. Both East Fork Fishing River sites are in reaches designated class “C” with LWW and AQL listed as beneficial uses.

Holmes Creek
Holmes Creek originates in east central Clay County near the town of Chandler in HU# 10300101060004. It flows east toward Mosby, where it enters Fishing River. The Holmes Creek watershed is approximately 15 square miles in area and the dominant land uses are pastureland, row crops, and forest. The Holmes Creek study site is located in a reach designated class “C” with beneficial uses LWW and AQL.

3.0 Site Descriptions

With the exception of Fishing River Station 1 and East Fork Fishing River 2, which were in Ray County, all Fishing River watershed sample stations were located in Clay County. The average width and discharge measurements during the survey period are given for each sampling station in Table 2 in the Data Results section.

Fishing River #1 (SW ¼ sec. 4, T. 51 N., R. 29 W.) was located downstream of West 88th Street. Geographic coordinates at the upstream terminus of this location were Lat. 39.25061207°, Long. -94.17009842°.

Fishing River #2 (NE ¼ sec. 21, T. 52 N., R. 30 W.) was located downstream of State Road H. Geographic coordinates at the upstream terminus of this location were Lat. 39.30617739°, Long. -94.27441919°.

Fishing River #3 (SW ¼ sec. 12, T. 52 N., R. 31 W.) was located downstream of Jesse James Farm Road. Geographic coordinates at the upstream terminus of this location were Lat. 39.33185203°, Long. -94.33696299°.

Fishing River #4 (SW ¼ sec. 8, T. 52 N., R. 31 W.) was located downstream of Plattsburg Road. Geographic coordinates at the upstream terminus of this location were Lat. 39.32885412°, Long. -94.41499176°.

East Fork Fishing River #1 (SW ¼ sec. 23, T. 52 N., R. 30 W.) was located downstream of NE 112th Street. Geographic coordinates at the upstream terminus of this location were Lat. 39.29452935°, Long. -94.24948821°.

East Fork Fishing River #2 (SW ¼ sec. 6, T. 52 N., R. 29 W.) was located upstream of Highway 10. Geographic coordinates at the downstream terminus of this location were Lat. 39.34247615°, Long. -94.20968515°.

Williams Creek #1 (NW ¼ SW ¼ sec. 16, T. 52 N., R.. 30 W.) was located downstream of NE 124th Street. Geographic coordinates at the upstream terminus of this location were Lat. 39.31723775°, Long. -94.28276558°.

Williams Creek #2 (NW ¼ SW ¼ sec. 33, T. 53 N., R. 30 W.) was located downstream of Schoolfield Road. Geographic coordinates at the upstream terminus of this location were Lat. 39.35771239°, Long -94.28336947°.

Carroll Creek #1 (SW ¼ sec. 30, T. 53 N., R. 30 W.) was located downstream of Highway 92. Geographic coordinates at the upstream terminus of this location were Lat. 39.36817928°, Long. -94.31660178°.

Carroll Creek #2 (NE ¼ sec. 19, T. 53 N., R. 30 W.) was located upstream of NE 164th Street. Geographic coordinates at the downstream terminus of this location were Lat. 39.38979798°, Long. -94.31300554°.

Muddy Fork #1 (SE ¼ sec. 23. T. 53 N., R. 31 W.) was located upstream of NE 164th Street. Geographic coordinates at the downstream terminus of this location were Lat. 39.38616166°, Long. -94.34869840°.

Muddy Fork #2 (NE ¼ sec. 2, T. 53 N., R 31 W.) was located downstream of NE 190th Street. Geographic coordinates at the upstream terminus were Lat. 39.43689979°, Long. -94.34815760°.

Clear Creek #1 (NW ¼ sec. 7, T. 52 N., R. 30 W.) was located downstream of NE 134th Street. Geographic coordinates at the upstream terminus were Lat. 39.33368557°, Long. -94.31569143°.

Clear Creek #3 (NE ¼ sec. 5, T. 53 N., R. 31 W.) was located downstream of NE 188th Street. Geographic coordinates at the upstream terminus were Lat 39.43426142°, Long. -94.39991239°.

Holmes Creek #1 (SE ¼ sec. 18, T. 52 N., R. 30 W.) was located downstream of NE 122nd Street. Geographic coordinates at the upstream terminus were Lat. 39.31373712°, Long. -94.31314065°.

4.0 Methods

4.1 Macroinvertebrate Collection and Analyses

A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003b). Three standard habitats—depositional substrate in non-flowing water, rootmat at the stream edge, and large woody debris—were sampled at all locations. Due to a paucity of rootmat habitat at Fishing River Station 4, only a partial sample was collected for analysis at this site.

A standardized sample analysis procedure was followed as described in the SMSBPP. The following four metrics were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) biotic index (**BI**); and Shannon Diversity Index (**SDI**). These metrics are scored and combined to form the Stream Condition Index (**SCI**). Stream Condition Indices between 20-16 qualify as biologically supporting, between 14-10 are partially supporting, and 8-4 are considered nonsupporting of aquatic life. The multi-habitat macroinvertebrate data are presented in Appendix C as laboratory bench sheets.

Additionally, macroinvertebrate data were analyzed in two specific ways. First, in Fishing River and for tributaries in which more than one station occurs, comparisons were made among up- and downstream reaches. This comparison addresses influences that may result from influxes from such sources as stormwater, wastewater, and tributaries. Longitudinal patterns for Fishing River are illustrated using XY line graphs with stream location (station number) on the X-axis and biological characteristics on the Y-axis. Data also are summarized and presented in tabular format comparing means of the four standard metrics and other parameters at each of the stations on Fishing River and each of the tributaries.

The standard four macroinvertebrate community metrics were calculated for each of the Fishing River major tributaries and compared to one another. Land use information, obtained using Geographic Informational System (**GIS**), also is compared among the major tributaries' watersheds to observe any potential relation between metric score and land use.

4.2 Physiochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations. Field measurements included temperature (°C), dissolved oxygen (mg/L), conductivity (µS/cm), and pH. Additionally, water samples were collected and analyzed by ESP's Chemical Analysis Section for turbidity (NTU), chloride, total phosphorus, ammonia-N, nitrate/nitrite-N, and total Kjeldahl nitrogen (**TKN**). Procedures outlined in Field Sheet and Chain of Custody Record (MDNR 2001) and Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations (MDNR 2003d) were followed when collecting water quality samples.

Stream velocity was measured at each station during the survey period using a Marsh-McBirney Flo-Mate™ Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113, Flow Measurement in Open Channels (MDNR 2003a).

Stream habitat characters for each sampling station were measured during the spring 2003 survey period using a standardized assessment analysis procedure as described for glide/pool habitat in the Stream Habitat Assessment Project Procedure (MDNR 2003c).

Physiochemical data were summarized and presented in tabular form for comparison among stations on Fishing River and its major tributaries.

4.3 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the SMSBPP and in accordance with the Fiscal Year 2004 Quality Assurance Project Plan for "Biological Assessment."

5.0 Data Results

5.1 Physiochemical Data

Physical characteristics of the sample stations on Fishing River and its major tributaries are presented in Table 2. Average stream widths at Fishing River ranged from 24 to 53 feet with widths tending to decrease while progressing upstream. The exception was Station 4, the uppermost site, which was 15 feet wider than Station 1, the lowermost site. Stream flow tended to decrease in upstream stations in the watershed, with several upstream sample stations having no measurable flow. At Clear Creek, the upper- and lowermost stations each had measurable flow, but the middle station was eliminated as a suitable sample site because the streambed was nearly dry. Drought conditions in northwestern Missouri during the fall and winter months prior to our sample season limited our ability to sample the upper reaches of some tributaries and in some instances diminished the amount of habitat available for macroinvertebrates.

Table 2
Physical Characteristics of the Stations

Creek	Station	Avg. Width (ft.)	Flow (cfs)
Fishing River	1	39	7.26
Fishing River	2	33	3.29
Fishing River	3	24	1.83
Fishing River	4	53	0.0
Clear Creek	1	38	0.27
Clear Creek	3	47	0.03
Muddy Fork	1	41	0.17
Muddy Fork	2	45	0.0
Carroll Creek	1	25	0.06
Carroll Creek	2	35	0.0

Table 2 (cont'd)

Creek	Station	Avg. Width (ft.)	Flow (cfs)
Williams Creek	1	17	0.30
Williams Creek	2	27	0.03
EF Fishing R.	1	23	0.55
EF Fishing R.	2	46	0.17
Holmes Creek	1	18	0.05

In situ water quality measurements are summarized in Table 3. Temperature among Fishing River sites was stable, varying no more than 2°C. The lowest temperature reading was recorded at Fishing River Station 2; this reading was taken earliest in the day among Fishing River sites. Among the tributaries temperature was, with the exception of East Fork Fishing River, higher at the upstream stations. At East Fork Fishing River, temperature at the stations varied only by a single degree, with the upstream site being lower.

Table 3
In situ Water Quality Measurements at all Stations

Creek/Station	Parameter				
	Temperature (°C)	Dissolved O_2 (mg/L)	Conductivity (µS/cm)	pH	Turbidity (NTU)
Fishing R. #1	15.0	8.6	677	8.1	53.9
Fishing R. #2	13.0	10.6	676	8.1	55.2
Fishing R. #3	14.0	13.9	738	8.5	16.7
Fishing R. #4	15.0	12.6	627	8.7	53.1
Clear Cr. #1	16.5	8.9	601	7.7	15.4
Clear Cr. #3	21.5	9.4	580	8.4	2.4
Muddy Fk. #1	13.5	10.3	584	7.8	7.9
Muddy Fk. #2	15.0	10.7	695	8.1	11.7
Carroll Cr. #1	15.0	10.3	620	8.3	7.4
Carroll Cr. #2	17.0	10.0	542	7.9	2.6
Williams Cr. #1	14.0	10.8	No data	8.0	15.8
Williams Cr. #2	16.5	10.3	549	8.1	18.3
EF Fishing R. #1	12.0	10.0	815	8.4	15.1
EF Fishing R. #2	11.0	11.0	No data	8.4	1.65
Holmes Cr. #1	16.5	9.5	663	8.0	18.6

Turbidity levels were generally higher in water samples collected from Fishing River than from its tributaries, averaging 54.1 NTU among three of the four sites (excluding Fishing River 3, which had an outlier result of 16.7 NTU). Turbidity among the tributaries showed no trends, except that the most turbid readings from the tributaries were comparable to or lower than the lowest reading observed at the Fishing River sample stations.

Conductivity and pH were consistent among sites with one exception. Conductivity at the downstream East Fork Fishing River site was elevated compared to the other sites. This reading

is likely related to the elevated chloride concentrations observed at the same site. Due to equipment malfunction, conductivity was not recorded for the upstream East Fork Fishing River station. We are, therefore, unable to make any definite inferences of whether this conductivity reading is typical of that found throughout East Fork Fishing River or whether the treatment facility directly upstream from the sample site was the cause.

Nutrient and chloride concentrations are presented in Table 4. Ammonia as nitrogen was below the detection limit of 0.05 mg/L for all but Fishing River Stations 1 and 3 and Carroll Creek Station 1. Measurable nitrate/nitrite levels were present at each of the Fishing River sample stations, with the highest readings occurring at Stations 1 and 4. Muddy Fork Station 1 was the only tributary at which nitrate/nitrite concentrations were observed above the detection limit. Concentrations of TKN and total phosphorus were variable among sites, but were generally higher at each of the Fishing River stations. Among Fishing River sites, the lowest concentrations of TKN and total phosphorus were observed at Station 2. Chloride concentrations were relatively consistent among Fishing River samples. The lowest chloride concentrations were observed at Fishing River Station 4, whereas the highest were observed just downstream at Station 3. Among all sites surveyed, the highest chloride concentrations were observed at the downstream East Fork Fishing River sample site. Although chloride levels at this site were nearly twice as high as the next nearest readings, other nutrient parameters associated with wastewater discharge (TKN, phosphorus, ammonia, and nitrate/nitrite) were not elevated compared to other sites in the watershed.

Table 4
Nutrient Concentrations at all Stations

Creek/Station	Parameter (mg/L)				
	NH_3-N	NO_2+NO_3-N	TKN	Total Phosphorus	Chloride
Fishing R. #1	1.47	1.50	2.57	0.30	67.4
Fishing R. #2	*	0.21	0.85	0.22	68.2
Fishing R. #3	0.12	0.82	2.32	0.35	77.2
Fishing R. #4	*	1.35	2.73	0.64	57.5
Clear Cr. #1	*	*	0.48	0.10	27.8
Clear Cr. #3	*	*	0.35	0.09	12.8
Muddy Fk. #1	*	0.05	0.53	*	28.1
Muddy Fk. #2	*	*	0.73	0.09	57.9
Carroll Cr. #1	0.06	*	0.46	0.07	28.4
Carroll Cr. #2	*	*	0.26	0.06	12.2
Williams Cr. #1	*	*	0.73	0.10	56.6
Williams Cr. #2	*	*	0.47	0.09	20.6
EF Fishing R. #1	*	*	0.53	0.10	132
EF Fishing R. #2	*	*	0.31	*	30.6
Holmes Cr. #1	*	*	1.03	0.20	60.8

*below detectable levels

5.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 5. According to the project procedure, for a study site to fully support a biological community, the total score from the physical habitat assessment should be 75% to 100% similar to the total score of a reference site. The mean habitat score for Little Drywood Creek, a biocriteria reference stream used for comparison, was 124. The mean habitat score among Fishing River sites was 111.8. All Fishing River watershed sites had habitat scores that were within the aforementioned range of similarity. It was therefore inferred that, based solely on habitat, the sites should be capable of supporting comparable biological communities.

Table 5
Reference Streams and Fishing River Watershed Habitat Assessment Scores

Reference Streams	Habitat Score	Fishing River Watershed Sites	Habitat Score	% of Mean Reference
Little Drywood #1	122	Fishing River #1	100	81
Little Drywood #2	126	Fishing River #2	127	102
		Fishing River #3	123	99
		Fishing River #4	97	78
		Clear Creek #1	124	100
		Clear Creek #3	102	82
		Muddy Fork #1	114	92
		Muddy Fork #2	99	80
		Carroll Creek #1	125	101
		Carroll Creek #2	108	87
		Williams Creek #1	107	86
		Williams Creek #2	104	84
		EF Fishing River #1	100	81
		EF Fishing River #2	93	75
		Holmes Creek #1	100	81
Mean Reference Stream Score	**124**			

5.3 Biological Assessment

5.3.1 Fishing River Mainstem

Metrics calculated for Fishing River and its tributaries were compared to biological criteria from the PMBL EDU biocriteria reference sites. These criteria for the spring sample season are presented in Table 6. This comparison was made to assess the degree to which using biological criteria was applicable for this watershed. Most biocriteria reference streams are fourth and fifth order and, although Fishing River is a fourth order stream, its tributaries tend to be second and third order. Larger streams may have more available habitat and higher numbers of macroinvertebrate taxa and diversity than smaller streams.

Table 6
Biological Criteria for Warm Water Reference Streams in the Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU, Spring Season

	Score = 5	Score = 3	Score = 1
TR	>50	50-25	<25
EPTT	>8	8-4	<4
BI	<7.16	7.16-8.58	>8.58
SI	>2.29	2.29-1.14	<1.14

Of the four Fishing River stations surveyed for macroinvertebrates, two (Stations 2 and 4) were biologically supporting, whereas the remaining two were partially supporting. Each of the stations exhibited identical metric scores with the exception of EPT Taxa. Stations achieving the rank of biologically supporting had more EPT taxa than the remaining stations, which resulted in a slightly higher Stream Condition Index (Table 7). The actual number of total taxa and EPT Taxa were higher at Station 2 than the other Fishing River sites (Figure 1). A total of four named tributaries as well as effluent from the Excelsior Springs wastewater facility enter Fishing River between Stations 1 and 2. Any one of these tributaries (or a combination of all) may contribute to the decline in water quality and biotic indices observed at Station 1.

5.3.2 Fishing River Tributaries

Scores of the individual metrics from each of the Fishing River tributary stations exhibited similar trends compared to those from the Fishing River mainstem (Table 8). Specifically, with the exception of EPT Taxa, metric scores were identical among nearly all sample stations (Muddy Fork Station 2 was the only site lacking sufficient taxa richness to achieve the top score of 5). As a result, little difference in SCI exists among the tributaries.

5.3.3 Comparisons of Fishing River and its Tributaries to Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biological Criteria

The four metrics calculated for Fishing River (Table 7) and its tributaries (Table 8) were roughly comparable to the biological criteria reference metrics. All sites exceeded the top score for the Shannon Diversity Index reference metric and all but one exceeded the taxa richness metric top score, despite the relatively small sizes of the tributaries.

5.3.4 Macroinvertebrate Percent and Community Composition

<u>Fishing River Mainstem</u>
The total number of macroinvertebrate taxa, EPT Taxa, and percent EPT for Fishing River and its tributaries is presented in Table 9. This table also provides percent composition data for the five dominant macroinvertebrate families at each sample station. The percent of relative abundance data were averaged from the sum of the three

Figure 1: Fishing River Taxa Richness and EPT Taxa

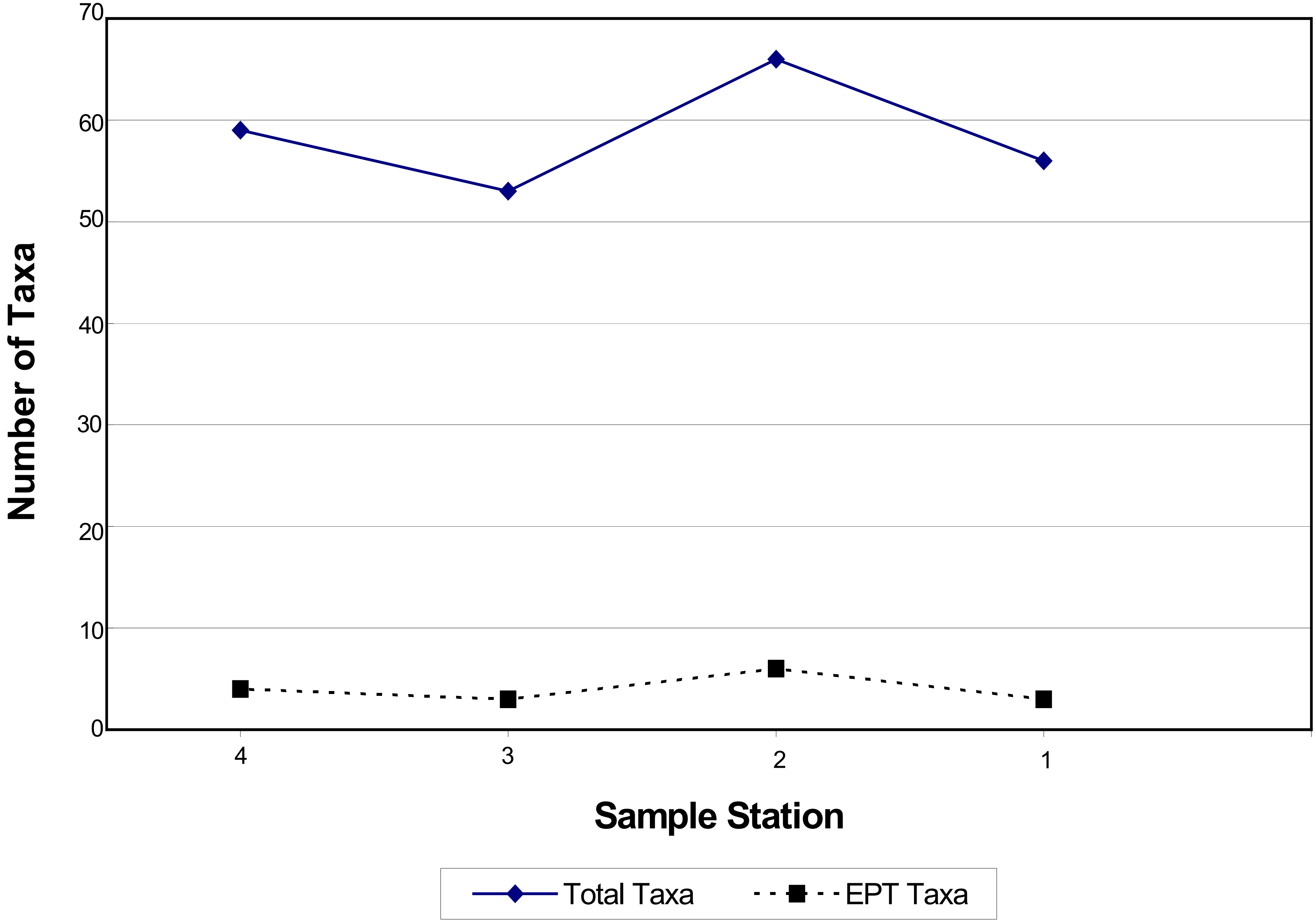

Table 7
Fishing River Metric Values and Scores, Spring 2003, Using Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biocriteria

Site #	TR	EPTT	BI	SDI	SCI	Support
#4 Value	59	4	8.06	2.98		
#4 Score	5	3	3	5	16	**Full**
#3 Value	53	3	7.43	2.61		
#3 Score	5	1	3	5	14	**Partial**
#2 Value	66	6	7.22	3.27		
#2 Score	5	3	3	5	16	**Full**
#1 Value	56	3	7.65	3.20		
#1 Score	5	1	3	5	14	**Partial**

Table 8
Fishing River Tributaries' Metric Values and Scores, Spring 2003, Using Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biocriteria

Site	TR	EPTT	BI	SDI	SCI	Support
Clear Cr. #1 value	77	7	7.46	3.09		
Clear Cr. #1 score	5	3	3	5	16	**Full**
Clear Cr. #3 value	51	3	7.79	2.81		
Clear Cr. #3 score	5	1	3	5	14	**Partial**
Muddy Fk. #1 value	67	8	7.26	3.35		
Muddy Fk. #1 score	5	3	3	5	16	**Full**
Muddy Fk. #2 value	50	5	7.23	3.27		
Muddy Fk. #2 score	3	3	3	5	14	**Partial**
Carroll Cr. #1 value	59	4	7.80	3.37		
Carroll Cr. #1 score	5	3	3	5	16	**Full**
Carroll Cr. #2 value	52	5	8.32	2.89		
Carroll Cr. #2 score	5	3	3	5	16	**Full**
Williams Cr. #1 value	62	3	8.14	3.14		
Williams Cr. #1 score	5	1	3	5	14	**Partial**
Williams Cr. #2 value	53	4	7.77	2.86		
Williams Cr. #2 score	5	3	3	5	16	**Full**
EF Fishing R. #1 value	59	2	8.24	2.95		
EF Fishing R. #1 score	5	1	3	5	14	**Partial**
EF Fishing R. #2 value	64	8	7.38	3.30		
EF Fishing R. #2 score	5	3	3	5	16	**Full**
Holmes Cr. #1 value	63	5	7.77	3.22		
Holmes Cr. #1 score	5	3	3	5	16	**Full**

Table 9
Spring 2003 Fishing River Watershed Macroinvertebrate Composition

	Fishing River				Clear Cr.		Muddy Fk.		Carroll Cr.		Williams Cr.		EF Fishing R.		Holmes Cr.
Variable-Station	1	2	3	4	1	3	1	2	1	2	1	2	1	2	1
Taxa richness	56	66	53	59	77	51	67	50	59	52	62	53	59	64	63
Number EPT Taxa	3	6	3	4	7	3	8	5	4	5	3	4	2	8	5
% Ephemeroptera	0.3	1.4	0.2	8.7	3.3	22.8	13.6	7.8	7.9	1.7	1.6	10.2	1.0	5.6	3.9
% Plecoptera	-	-	-	-	-	-	-	-	0.3	0.5	-	0.3	-	-	-
% Trichoptera	0.1	2.2	0.3	0.4	1.1	0.3	1.2	0.9	0.2	0.3	0.2	0.4	-	1.0	0.1
% Dominant Families															
Chironomidae	72.2	59.4	55.1	70.1	55.4	33.7	49.8	50.0	49.1	45.7	44.2	53.2	53.2	29.2	63.6
Elmidae	6.3	3.0	-	-	2.9	-	9.2	-	-	-	6.7	4.0	1.9	6.1	3.3
Tubificidae	5.3	5.5	6.7	4.0	8.6	5.4	4.4	-	11.9	10.9	10.0	8.6	26.4	12.4	15.4
Physidae	3.8	-	7.5	2.6	3.9	-	-	-	-	6.0	18.2	-	3.6	-	-
Corixidae	3.6	13.3	17.9	-	-	-	-	-	-	-	-	-	-	-	-
Coenagrionidae	-	7.4	3.4	-	-	-	-	-	-	-	-	-	-	-	-
Caenidae	-	-	-	8.5	-	22.7	11.8	7.6	6.4	-	-	10.1	-	-	3.2
Lymnaeidae	-	-	-	2.7	-	9.6	3.8	5.4	6.7	10.9	-	10.5	-	-	-
Ceratopogonidae	-	-	-	-	14.8	-	-	12.7	5.3	-	-	-	-	15.8	2.4
Ancylidae	-	-	-	-	-	6.7	-	-	-	-	-	-	-	-	-
Dytiscidae	-	-	-	-	-	-	-	3.9	-	-	-	-	-	-	-
Sphaeriidae	-	-	-	-	-	-	-	-	-	8.5	9.5	-	3.9	-	-
Hyalellidae	-	-	-	-	-	-	-	-	-	-	-	-	-	9.3	-

macroinvertebrate habitats (nonflow, large woody debris, and rootmat) sampled at each station. Spring 2003 macroinvertebrate samples from Fishing River averaged 59 total taxa (range 53-66) and 4 EPT Taxa (range 3-6). Midge larvae (Chironomidae) were the dominant taxa among all Fishing River sites; although aquatic worms were variable in their relative rankings among sites, they were present as one of the top five taxa at each Fishing River site. No trends relative to position in the drainage were apparent among Fishing River sites. Station 2, which was located downstream from the majority of sites in the watershed, exhibited some of the best macroinvertebrate scores compared to other mainstem sites with the highest taxa richness, EPT Taxa, and percent caddisflies (Trichoptera). Fishing River Station 3, approximately 5.3 miles upstream from Station 2, had the fewest total taxa and was tied with Station 1 for fewest EPT Taxa. Station 3 also had the lowest percentage of chironomids among Fishing River sites.

<u>Fishing River Tributaries</u>
Macroinvertebrate samples from the 11 sites among the Fishing River tributaries averaged 60 total taxa (range 77-50) and 5 EPT Taxa (range 2-8). Chironomids were among the top five taxa at all sites and tubificid worms were among the top five taxa at all sites except for the upstream Muddy Fork station. Stoneflies (Plecoptera) were present in low numbers (≤4 individuals) only at the two Carroll Creek stations and the upstream Williams Creek site.

With the exception of East Fork Fishing River, all downstream sites had higher taxa richness scores than their upstream counterparts. East Fork Fishing River Station 1 also had the lowest number of EPT Taxa, was the only site lacking caddisflies (Trichoptera), and had the highest percentage of tubificid worms in samples, nearly double that of the next nearest site. East Fork Fishing River Station 2, approximately 6.7 miles upstream, had the lowest percentage of chironomids and tied for the highest number of EPT Taxa.

The upstream Clear Creek station had the second lowest percentage of chironomids and the highest percentage of mayflies (Ephemeroptera) among all sample sites. The downstream Clear Creek station had the highest taxa richness and tied for second most EPT Taxa. This site also had the highest percentage of chironomids and the second highest percentage of caddisflies among the tributaries.

The downstream Muddy Fork station had the second highest taxa richness and EPT Taxa among tributaries. This site also had the highest percentage of caddisflies among tributary samples. The upstream Muddy Fork site was the only station in which tubificid worms were not ranked among the most numerous five taxa.

<u>Biocriteria Reference Streams</u>
Spring macroinvertebrate data for one PMBL EDU biocriteria reference stream (East Fork Crooked River) and one Plains/Osage EDU biocriteria reference stream (Little Drywood Creek) are presented in Table 10. Macroinvertebrate data from these streams, sampled between 1995 and 2001, are to provide a comparison with the macroinvertebrate fauna of the Fishing River watershed.

Table 10
Plains/Osage EDU and Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU Biocriteria Reference Stream Macroinvertebrate Composition, Spring Season

	East Fork Crooked R.		Little Drywood Creek					
Sample Year	1999	2000	1995		1998		2000	2001
Station-Variable	1	1	1	2	0	2	1	1
Taxa richness	65	48	50	56	69	73	74	50
Number EPT	13	7	8	10	13	16	14	8
% Ephemeroptera	16.7	0.5	20.5	15.3	9.7	12.1	4.5	2.5
% Plecoptera	0.4	0.1	4.0	4.7	3.1	3.2	0.9	0.9
% Trichoptera	3.4	0.4	0.3	4.7	0.8	0.6	0.6	0.6
% Dominant Families								
Chironomidae	70.9	66.4	27.8	48.6	31.7	46.9	56.1	71.5
Baetidate	9.2	-	-	-	-	-	-	-
Heptageniidae	5.9	-	7.9	8.4	-	-	-	-
Tubificidae	3.3	15.6	-	5.2	14.5	17.2	12.0	5.8
Hydropsychidae	3.1	-	-	-	-	-	-	-
Ceratopogonidae	-	7.6	-	-	-	-	3.4	-
Simuliidae	-	3.3	18.0	-	23.8	5.2	4.1	6.2
unidentified dipteran	-	1.7	-	-	-	-	-	-
Hyalellidae	-	-	13.1	5.5	-	-	-	-
Caenidae	-	-	9.7	3.7	4.3	6.6	-	-
Asellidae	-	-	-	3.7	8.2	6.6	-	4.6
Limnephilidae	-	-	-	3.7	-	-	-	-
Acarina	-	-	-	-	-	-	3.3	-
Enchytraeidae	-	-	-	-	-	-	-	2.0

Taxa richness for the biocriteria reference streams ranged from 48 to 74 and total EPT Taxa ranged from 8 to 16 during spring sample seasons. With respect to taxa richness and EPT Taxa, considerable variability was observed among years for each sample station. As was observed with the Fishing River watershed samples, chironomids and tubificids were among the dominant taxa at each sampling event. Black fly larvae (Simuliidae) were among the dominant taxa in both streams in all but two instances at the reference streams; in contrast, black flies were observed in low densities at only two sites in the Fishing River watershed.

6.0 Discussion

With few exceptions, little variability in habitat, water quality, or macroinvertebrate indices was observed among sites in the Fishing River watershed. For instances in which large changes occurred or where observations have run contrary to trends observed among the remaining sites, further explanation and speculation into potential causes is offered. As a result, the Discussion section tends to focus on apparent extremes in observations, both good and bad.

Fishing River Station 4, the most upstream site on the mainstem of Fishing River was located approximately 2.7 miles downstream from the Kansas City, Fishing River Wastewater Treatment Facility (**WWTF**). Because this treatment facility was located so far upstream in the watershed, it was not feasible to establish a baseline sampling station on the mainstem that was not influenced by wastewater discharge. As a result, several water quality parameters observed at our upstream sample site, which normally would serve as a basis of comparison for downstream stations, were similar to or worse than the other Fishing River sites.

Fishing River Station 1, the most downstream mainstem site, had higher NH_3-N and NO_2+NO_3-N concentrations than any other site in the watershed. In addition, TKN and phosphorus readings were among the highest observed. Although Fishing River Station 1 receives the combined flow of 21 permitted wastewater treatment facilities ranging from septic tanks and lagoons to municipal wastewater treatment plants, this fact alone does not explain the elevated nutrient concentrations. If cumulative effects of wastewater treatment facilities were the sole cause, one would expect that Fishing River Station 2, which was located approximately 12.5 miles upstream of Station 1, also would have comparable or slightly lower nutrient readings. In fact, Station 2 had the lowest NO_2+NO_3-N, TKN, and phosphorus concentrations among Fishing River sites.

Several macroinvertebrate differences also were observed at Fishing River Station 1 compared to Station 2. The downstream Fishing River station exhibited lower taxa richness and EPT Taxa as well as a lower percentage of mayflies, caddisflies, and water boatmen (Corixidae) compared to samples collected from Fishing River Station 2. At the same time, we observed increases in the percentage of chironomids, riffle beetles (Elmidae), and physid snails (Physidae) in the downstream station. According to their biotic index values, the taxa mentioned previously that exhibited declines (or elimination) in the downstream station all were in the range of moderately insensitive to organic pollutants. One group that was more abundant in Station 1, physid snails, is very tolerant; the others, chironomids and elmids, are variable.

Considering the degree of variation in biotic indices among Fishing River sites, these observations could be further examples of this variability. It is also possible, however, that the water quality and biotic indices of the mainstem Fishing River stations are influenced by their proximity to municipal wastewater effluent discharge. Fishing River Station 4 is approximately 2.7 miles downstream from the Kansas City, Fishing River WWTF and Station 3 is approximately 1.2 miles downstream from the Kearney Sequential Batch Reactor WWTF. Station 2, on the other hand, is 6.5 miles downstream from the nearest effluent discharge point, which may account for some of the improving trends of water quality and biotic indicators observed at this site. Fishing River Station 1 is approximately 12 miles downstream from the Excelsior Springs WWTF discharge point. Although there is greater distance between Fishing River Station 1 and the nearest discharge, the volume of effluent (actual flow) produced by the Excelsior Springs facility is more than triple the combined flow produced by the North Kansas City and Kearney facilities. A logical conclusion might be that this wastewater influx is sufficient to cause Fishing River Station 1 water quality and biotic indicators to fall back to levels more comparable to Stations 3 and 4.

East Fork Fishing River, which flows through Excelsior Springs, also may contribute to the decline of water quality and biotic indicators observed at Fishing River Station 1. None of the nutrient parameters that we tested from the downstream East Fork Fishing River station except chloride, however, are elevated in comparison to the relatively low levels observed at Fishing River Station 2. Although the levels of nutrients and water quality parameters observed in East Fork Fishing River may not be obvious factors contributing to the Fishing River macroinvertebrate decline observed between Stations 2 and 1, there may be other factors present that our analyses did not detect. Based on the decline of certain East Fork Fishing River macroinvertebrate indices in the downstream station (discussed below), there may be some agent associated with urban runoff, agricultural runoff, or some unknown that also contributes to the macroinvertebrate decline in Fishing River.

East Fork Fishing River was the only tributary in this study in which taxa richness was lower in samples collected from its downstream station. It also exhibited the sharpest drop in EPT Taxa, from 8 to 2, as well as the complete elimination of caddisflies at the downstream site. In the same reach, tubificid worms more than doubled in their abundance and chironomids nearly doubled. Habitat scores, however, were similar between sites, with the downstream site being slightly higher, and flow was slightly higher at the downstream site. Among detectable nutrient parameters at East Fork Fishing River--TKN, total phosphorus, and chloride--all were higher at the downstream site. Of particular note was chloride, which climbed from 30.6 mg/L at the upstream site to 132 mg/L at the downstream site. Given the naturally-occurring mineral springs in Excelsior Springs, the elevated chloride levels may be at least partially attributable to spring influence. Turbidity was 1.65 NTU at Station 2 (the lowest among all sites) and was 15.1 NTU at Station 1 which, although not particularly high when compared to the other Fishing River tributaries, was a considerable change between the up- and downstream sites. Finally, the downstream East Fork Fishing River site had higher conductivity than water samples collected from all other sites (815 µS/cm). This elevated conductivity observation may be linked to the increased concentration of chloride mentioned above. Unfortunately, we were unable to conduct a conductivity reading at the upstream site for comparison due to meter failure.

Drought conditions in northwestern Missouri may have played a role in certain water quality and macroinvertebrate parameters. Very little precipitation had fallen in this portion of the state in the months preceding our study. The resultant lack of high flows during the preceding fall and winter months likely resulted in the thick deposits of leaves and, at the upstream East Fork Fishing River site, thick mats of filamentous algae remaining at our study sites. Limited flows also may have served to provide less dilution to possible nutrient-rich discharges entering streams in the Fishing River watershed. Drought conditions also slightly altered the scope of this project. Several upstream sites were removed from consideration due to lack of water. Of particular interest were the upper reaches of Williams Creek and East Fork Fishing River. Each of these streams is impounded and, in the case of Crystal Lakes on East Fork Fishing River, is part of a lakeside suburban community. Although the lake itself experiences periodic seasonal dissolved oxygen depletion and fish kills (Steve Fisher, MDC Fisheries Biologist, pers. comm.), these particular water quality problems have not been observed on East Fork Fishing River. Watkins Mill Lake is a reservoir on Williams Creek and is on the 303(d) list of impaired waters for excessive fecal coliform. Our original intent was to sample upstream of each of these reservoirs in an effort to observe whether any water quality or bioassessment parameter trends could be associated with stream gradient and the presence of reservoirs. Although it may be possible to conduct this type of sampling during a normal rainfall year, the study sites at both streams were class "C" and any sampling further upstream may not yield meaningful results using bioassessment protocols.

Although habitat scores for all study sites fell within the range of similarity compared to reference sites, over half of the sites were between 75 and 85% similar and neared the point at which habitat quality might be considered questionable. Factors leading to lower scores at these sites were largely attributable to channel flow status (the percentage of water filling the available channel) and vegetative protection of streambanks (including the amount of vegetation covering a streambank, bank stability, and riparian zone width). Sites with the lowest scores tended to have the least amount of flow as well as some memorably steep, unstable banks.

7.0 Summary

1. With the exception of Fishing River Station 2, which exhibited some comparatively good water quality and biotic indices, there were few notable differences among Fishing River sites.

2. Proximity to effluent discharge points from wastewater treatment facilities appears to be suppressing the macroinvertebrate community in Fishing River. Fishing River Station 2 was relatively removed from wastewater influence and exhibited the best macroinvertebrate and water quality indicators among the mainstem sites.

3. The highest degree of decline among macroinvertebrate and water quality parameters occurred at East Fork Fishing River Station 1 compared to its upstream counterpart.

4. Factors contributing to the lower habitat scores among sites were metrics associated with low flows and bank stability.

5. The Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure found that Fishing River Stations 2 and 4 were biologically supporting, whereas Stations 1 and 3 were partially supporting.

6. Carroll Creek was the only tributary in which both stations had biologically supporting scores. It also lies in the only watershed lacking any permitted wastewater discharge. The remaining tributaries all had one station with biologically supporting and one station with partially supporting macroinvertebrate scores. No trends were observed with respect to these stations' position in the watershed.

7. All sample sites in the watershed scored either 14 or 16, straddling the dividing point between biologically supporting and partially supporting. None of the stations exhibited macroinvertebrate community scores approaching those of high quality communities, i.e., scores of 18 or 20.

8.0 Literature Cited

Missouri Department of Natural Resources. 2001. Field Sheet and Chain of Custody Record. MDNR Environmental Services Program. Jefferson City, Missouri. 8 pp.

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Missouri Department of Natural Resources. 2003b. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. MDNR Environmental Services Program. Jefferson City, Missouri. 24 pp.

Missouri Department of Natural Resources. 2003c. Stream Habitat Assessment Project Procedure. MDNR Environmental Services Program. Jefferson City, Missouri. 40 pp.

Missouri Department of Natural Resources. 2003d. Required/Recommended Containers, Volumes, Preservatives, Holding Times, and Special Sampling Considerations. MDNR Environmental Services Program. Jefferson City, Missouri. 21 pp.

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Appendix A

Proposed Bioassessment Study Plan
Fishing River
February 11, 2003

Missouri Department of Natural Resources
Bioassessment Study Plan
Fishing River Watershed--Clinton, Clay, and Ray Counties
February 11, 2003

Background

The Fishing River watershed is approximately 282 square miles and originates in central Clay County, Missouri with major tributaries entering from the north and east. For purposes of this study, major tributaries include Clear Creek, Muddy Fork, Carroll Creek, Williams Creek, Holmes Creek, and East Fork Fishing River. The upper portion of Fishing River lies in a mostly rural setting, flowing through Kearney and Excelsior Springs before entering the Missouri River near Orrick. Fishing River lies in the Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU. It is a stream of low relative gradient with dolomite-limestone geology in the upper watershed and alluvium further downstream.

Although much of the watershed remains rural, Clay County has experienced tremendous growth during the past decade. According to the Clay County Comprehensive Plan (amended 1999), the current land development pattern has the potential to consume much of the county's remaining rural land in the early 21st century. U.S. Census data indicate that Clay County's population has grown 20 percent since 1990. The Kansas City area continues to spread toward this area; in addition, populations of towns such as Kearney and Excelsior Springs are growing, resulting in an accelerated rate of water quality decline in this watershed.

Streams subjected to urban development are particularly vulnerable to water quality and habitat degradations. Potential water quality stressors include the addition of point source pollutants (e.g., wastewater treatment plant or other permitted discharges, accidental or deliberate spills, and illegal dumping), nonpoint source pollutants (e.g., sediment and nutrients due to increased runoff; toxic chemicals such as petroleum products, metals, pesticides, and fertilizers), and hydrologic alterations (e.g., increased downstream flooding, reduced base flows). In addition, habitat losses often result from residential or commercial development. The degree to which these impacts occur in the Fishing River watershed is unknown and has prompted a joint effort between the Missouri Department of Natural Resources (MDNR) and the Missouri Department of Conservation (MDC) to study the current status of the watershed.

Objectives

We propose that an assessment of the aquatic fauna of the Fishing River watershed be conducted now as a baseline, prior to further development occurring. Our objectives are to: 1) determine whether there is greater aquatic life impairment in the most downstream portions of Fishing River relative to sections upstream that are isolated from tributaries that serve as receiving systems for permitted point-source facilities; 2) rank

macroinvertebrate community metric scores from each of the major tributaries and compare the rankings to the level of human disturbance in each Fishing River major sub-watershed; 3) establish a baseline to document the condition of the aquatic fauna as it currently exists as a point of comparison for future studies; 4) supplement fish community information gathered by MDC in this watershed.

Null Hypotheses

1) Macroinvertebrate assemblages will not differ among longitudinally separate reaches of Fishing River, separated relative to tributary influence.

2) Measures of habitat quality will not differ among longitudinally separate reaches of Fishing River.

3) The ranking of biological metrics and levels of human disturbance will not differ among Fishing River sub-watersheds.

Study Design

General: The study area brackets approximately 14 miles of mainstem Fishing River as well as 31 miles of Fishing River tributaries. The upstream boundary on Fishing River is located southwest of Kearney at the Plattsburg Road bridge crossing; the downstream boundary is northeast of Missouri City at the Greenwood Road bridge crossing. A total of four Fishing River stations will be surveyed with an additional 12 stations among the major tributaries.

Biological Sampling: Each macroinvertebrate station will consist of a length approximately 20 times the average stream width, and will contain at least two riffle areas. To assess variability among sample stations, stream discharge measurements, water quality samples, and habitat assessments will be recorded during macroinvertebrate surveys. Sampling will be conducted during spring 2003 (March 15 through April 15).

Macroinvertebrates will be sampled according to the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Fishing River and its tributaries will be considered a “riffle/pool” dominated stream, with samples to be collected from flow over coarse substrate, depositional (non-flow), and rootmat habitats. Each macroinvertebrate sample will be a composite of six subsamples within each habitat.

Water Quality Sampling: Water samples from all sampled stations will be analyzed at the ESP laboratory for ammonia, nitrogen as NO_2+NO_3, total Kjeldahl nitrogen, total phosphorus, chloride, and turbidity. Field measurements will include pH, conductivity, temperature, and dissolved oxygen.

Habitat Sampling Methods: Stream discharge will be measured at each sampling location using a Marsh-McBirney flow meter. Stream habitat assessments also will be conducted within each study area following the guidelines of MDNR-FSS-032.

Laboratory Methods: All samples of macroinvertebrates will be processed and identified as per MDNR-FSS-209, Taxonomic Levels for Macroinvertebrate Identification. Turbidity samples will be analyzed at the MDNR biological laboratory.

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database in accordance with MDNR-WQMS-214, Quality Control Procedures for Data Processing. Data analysis is automated within the Access database. Four standard metrics are calculated according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Index (SI) will be calculated for each reach.

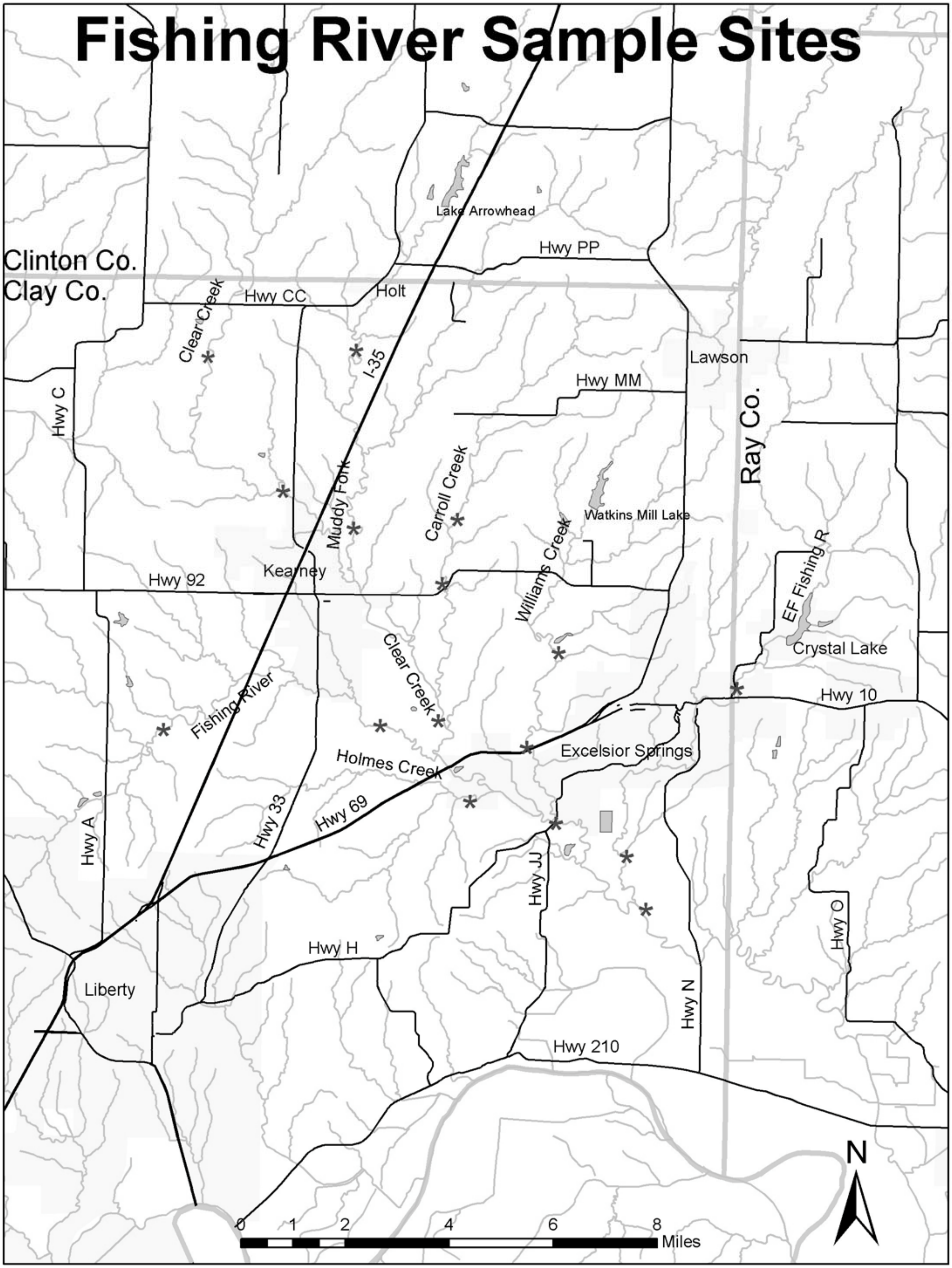
Macroinvertebrate data for Fishing River and for tributaries in which more than one station occur will be compared longitudinally. This longitudinal comparison will compare reaches upstream and downstream of potential influences (e.g., stormwater or wastewater, influx of water from tributaries). Longitudinal patterns will be illustrated using XY line graphs with stream location (station number) on the X-axis and biological characteristics on the Y-axis. Data also will be summarized and presented in bar graphs comparing means of the four standard metrics and other parameters at each of the stations on Fishing River and each of the tributaries.

The standard four macroinvertebrate community metrics will be calculated for each of the Fishing River major tributaries and compared to one other. Land use information, obtained using GIS, also will be compared among the major tributaries' watershed to observe any potential relation between metric score and land use.

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

Attachments: Map of the Fishing River watershed with sampling stations.



Fishing River Sample Sites
Lake Arrowhead
Hwy PP
Clinton Co.
Clay Co.
Clear Creek
Hwy CC
Holt
I-35
Lawson
Hwy MM
Hwy C
Ray Co.
Muddy Fork
Carroll Creek
Watkins Mill Lake
Williams Creek
EF Fishing R
Hwy 92
Kearney
Crystal Lake
Clear Creek
Fishing River
Hwy 10
Excelsior Springs
Holmes Creek
Hwy 33
Hwy 69
Hwy A
Hwy JJ
Hwy O
Hwy H
Liberty
Hwy N
Hwy 210
N
0 1 2 4 6 8
Miles

Appendix B

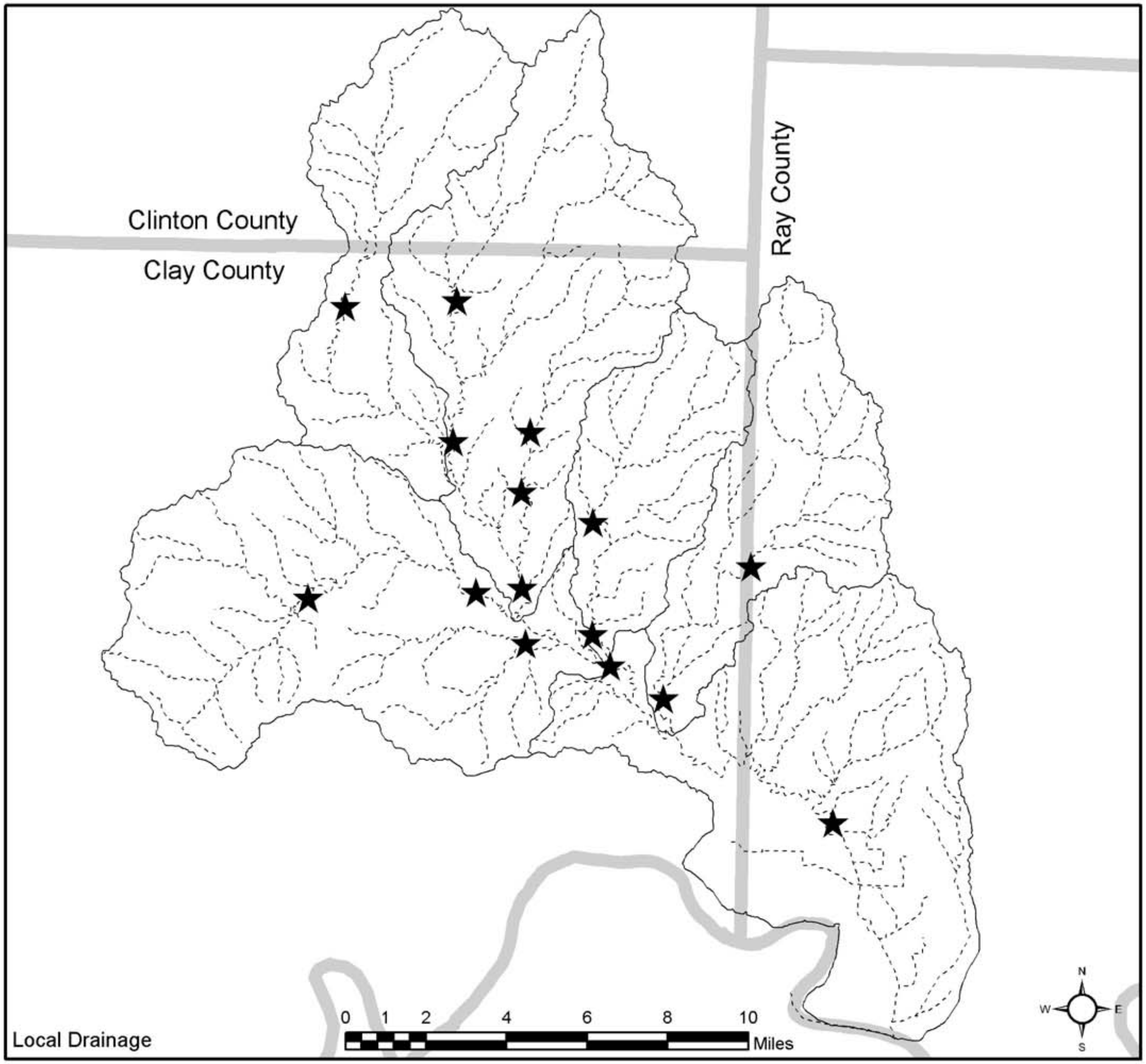
Maps

Fishing River Watershed
Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU

&

Fishing River Sample Stations
Plains/Missouri Tributaries between the Blue and Lamine Rivers EDU

Fishing River Watershed



Sampling Location

County Boundary

Local Drainage

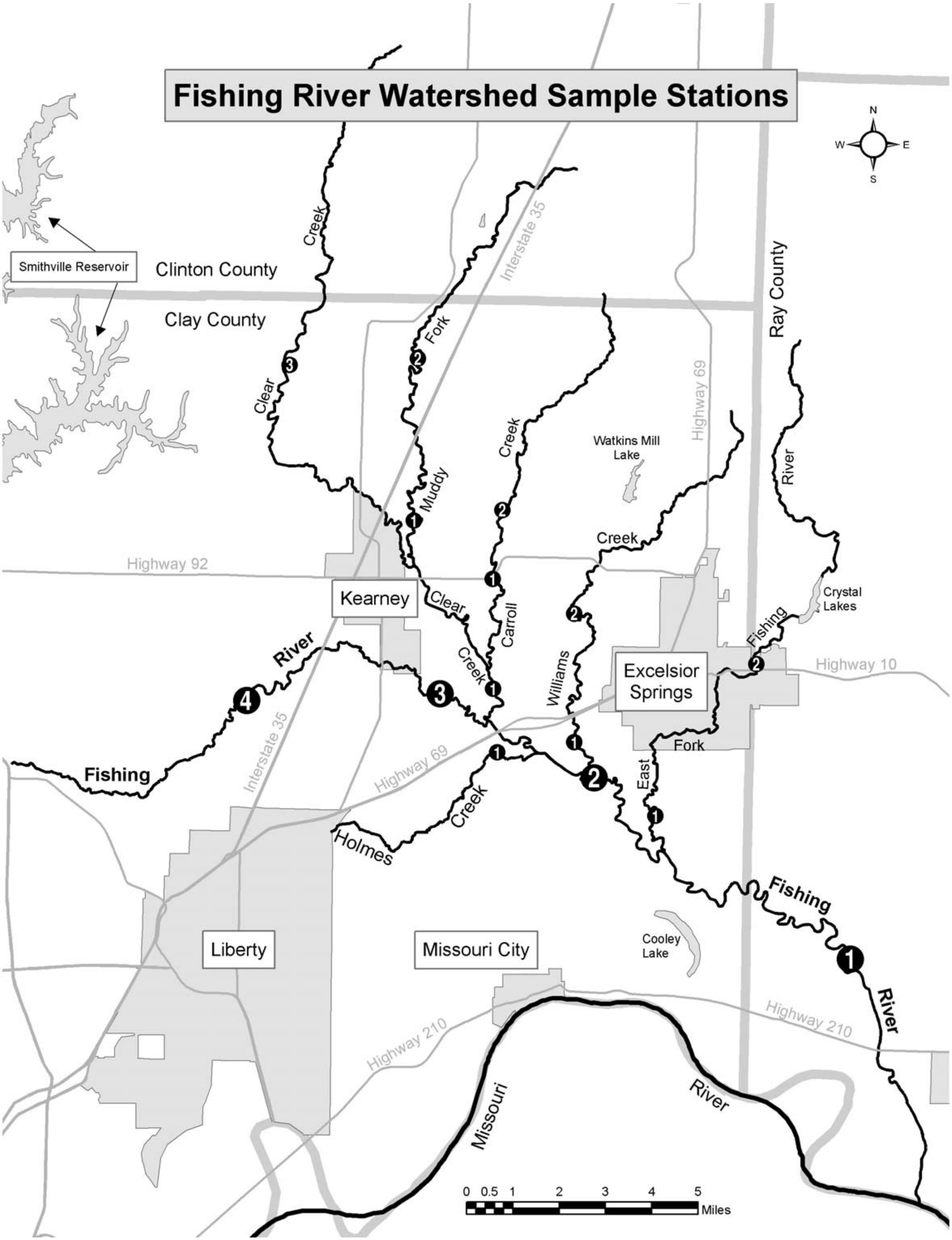
Stream/River

Local Drainage and Biologic Sampling Site Location

Ecolocial Drainage Unit (EDU) - An EDU is an area that contains a unique combination of habitats and organisms. Missouri is divided into 19 EDUs as shown in the inset map below. This site is located in the highlighted EDU.

Local Drainage - The local drainage area, also known as a 14 Digit Hydrologic Unit, is shown in the main map at left. This area is a portion of the local watershed. Missouri is split into over 1500 such units.

Ecological Drainage Unit



Fishing River Watershed Sample Stations
N
W
E
S
Smithville Reservoir
Clinton County
Clay County
Ray County
Interstate 35
Highway 69
Highway 92
Highway 10
Highway 210
Clear Creek
Muddy Fork
Carroll Creek
Williams Creek
East Fork
Holmes Creek
Fishing River
Watkins Mill Lake
Crystal Lakes
Cooley Lake
Kearney
Excelsior Springs
Liberty
Missouri City
Missouri River
0 0.5 1 2 3 4 5
Miles

Appendix C

Fishing River Watershed Macroinvertebrate Taxa Lists

Fishing River #1a: Spring 2003

Taxa	NF	RM	SG
Acarina	2	1	
Berosus	-99		
Dubiraphia	6	14	2
Macronychus glabratus	1	14	16
Peltodytes	1		
Stenelmis	4		
Ablabesmyia	1	4	
Ceratopogoninae	14	4	3
Chironomus	9		1
Cricotopus bicinctus			1
Cricotopus/Orthocladius		12	86
Cryptochironomus	10		
Cryptotendipes	17		1
Dicrotendipes	5	30	55
Diplocladius			1
Diptera	2		
Dolichopodidae	1		
Glyptotendipes		15	8
Hemerodromia			3
Hydrobaenus	11	36	51
Nanocladius		1	
Paracladopelma	2		
Paralauterborniella	23		
Parametriocnemus			1
Paraphaenocladius	2	6	4
Paratanytarsus		2	
Paratendipes	2		
Phaenopsectra		1	7
Polypedilum convictum grp		1	3
Polypedilum halterale grp	32		1
Polypedilum illinoense grp	4	44	31
Polypedilum scalaenum grp	6	1	2
Procladius	35		
Rheocricotopus			1
Stelechomyia			1
Tanytarsus	3	21	19
Thienemannimyia grp.		19	21
Tribelos	1		
Zavrelimyia		2	
Stenacron	1	1	1
Belostoma		-99	
Ranatra nigra		1	
Trichocorixa	27	6	
Ferrissia	2	1	2

Fishing River #1a (continued): Spring 2003

Fossaria		3	
Physella	6	21	8
Argia	4	19	
Enallagma		1	
Hydropsyche	-99		
Nectopsyche	1		
Branchiura sowerbyi	6		
Limnodrilus cervix	5		
Limnodrilus claparedianus	4		
Limnodrilus hoffmeisteri	1	1	
Tubificidae	31		
Sphaeriidae	1	3	6

NF = Non-flow Habitat
RM = Rootmat Habitat
SG = Snag (i.e., Large Woody Debris Habitat)
-99 = Present in Samples

Fishing River #1b: Spring 2003

Taxa	NF	RM	SG
Berosus		1	
Dubiraphia	7	8	
Helichus lithophilus		1	
Macronychus glabratus	1	7	1
Stenelmis	2	1	1
Palaemonetes kadiakensis		1	
Ablabesmyia	2	1	1
Ceratopogoninae	4	9	3
Chironomus	31	1	1
Cricotopus bicinctus		1	4
Cricotopus/Orthocladius	1	31	86
Cryptochironomus	5	1	1
Cryptotendipes	9		
Dicrotendipes	2	17	51
Eukiefferiella			1
Glyptotendipes	1	11	1
Gonomyia	2		
Hemerodromia			1
Hydrobaenus	7	38	52
Nanocladius	1	5	
Natarsia			1
Paracladopelma	1		
Paralauterborniella	21		
Paraphaenocladius	2	7	9
Phaenopsectra		1	3
Polypedilum halterale grp	16		1
Polypedilum illinoense grp		44	38
Polypedilum scalaenum grp	1		2
Procladius	37	9	1
Pseudosmittia		1	
Rheocricotopus			2
Simulium			1
Tanytarsus	3	9	16
Thienemannimyia grp.		17	8
Zavrelimyia		2	
Ranatra fusca		1	
Ranatra nigra		1	
Trichocorixa	9	10	
Ferrissia	4		
Fossaria		2	
Physella	4	26	8
Argia	4	20	
Macromia	1		
Nasiaeschna pentacantha		-99	

Fishing River #1b (continued): Spring 2003

Nectopsyche	2	6	1
Aulodrilus	6		
Branchiura sowerbyi	18		
Enchytraeidae	1		
Limnodrilus cervix	19		
Limnodrilus claparedianus	3		
Limnodrilus hoffmeisteri	6	1	
Tubificidae	53		
Sphaeriidae	5	1	15

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Fishing River #2: Spring 2003

Taxa	NF	RM	SG
Hyalella azteca		8	
Dubiraphia	5	16	1
Helichus lithophilus		2	
Hydrochus		1	
Hydroporus	1		
Laccophilus		1	
Macronychus glabratus		5	
Peltodytes	4		
Stenelmis		1	1
Palaemonetes kadiakensis	-99		
Ablabesmyia		1	
Ceratopogoninae	5	11	10
Chironomus	6		
Cladotanytarsus		1	1
Cricotopus bicinctus		1	3
Cricotopus/Orthocladius		6	83
Cryptochironomus	8		
Cryptotendipes	3		
Dicrotendipes	1	13	64
Diplocladius			1
Glyptotendipes	1	4	25
Hydrobaenus	11	4	14
Nanocladius		5	1
Parachironomus		4	
Paracladopelma	2		
Parakiefferiella		1	22
Paralauterborniella	14		4
Paraphaenocladius	1	1	1
Paratanytarsus		3	
Phaenopsectra			8
Polypedilum convictum grp			12
Polypedilum halterale grp	6		1
Polypedilum illinoense grp		45	11
Polypedilum scalaenum grp	5		7
Procladius	17	1	1
Rheocricotopus			2
Rheotanytarsus		2	2
Simulium			8
Stenochironomus			1
Stictochironomus	1		
Tabanus	1		
Tanypus	1		
Tanytarsus	5	29	9
Thienemanniella			4

Fishing River #2 (continued): Spring 2003

Thienemannimyia grp.	1	57	29
Caenis latipennis	1		
Stenacron	2	2	8
Microvelia		1	
Trichocorixa	126		1
Noctuidae		1	
Physella	2	10	3
Argia	7	62	2
Basiaeschna janata		-99	
Glossiphoniidae	1		
Cheumatopsyche			10
Hydropsyche	1		5
Nectopsyche		4	
Oecetis	1		
Aulodrilus	2		
Branchiura sowerbyi	6		
Enchytraeidae			1
Limnodrilus cervix	7		
Limnodrilus claparedianus	2		
Limnodrilus hoffmeisteri	9		1
Tubificidae	22	1	3
Sphaeriidae	2		

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Fishing River #3: Spring 2003

Taxa	NF	RM	SG
Branchiobdellida	1		
Acarina	1		
Hyalella azteca		6	
Erpobdellidae	1		
Berosus			1
Dubiraphia	4	15	4
Hydroporus	1	2	
Peltodytes	1		
Ablabesmyia		2	2
Ceratopogoninae	11	1	1
Chaoborus	1	1	
Chironomus	9		1
Cladotanytarsus	1		
Corynoneura			2
Cricotopus/Orthocladius	2	3	4
Cryptochironomus	28		3
Cryptotendipes	1		
Dicrotendipes		66	221
Forcipomyiinae			1
Glyptotendipes		6	13
Hydrobaenus	2	4	3
Nanocladius			1
Paralauterborniella	1		
Paraphaenocladius		1	1
Paratanytarsus		2	2
Phaenopsectra		2	2
Polypedilum halterale grp			1
Polypedilum illinoense grp		7	6
Polypedilum scalaenum grp	1		3
Procladius	9	2	4
Stenochironomus			1
Tanytarsus		2	6
Thienemannimyia grp.	1	47	47
Caenis latipennis	1	1	
Ranatra fusca		1	
Ranatra nigra		1	
Trichocorixa	166	2	2
Fossaria		4	-99
Physella	3	66	2
Argia	1	5	8
Enallagma	1	17	
Ischnura		1	
Nasiaeschna pentacantha		2	
Hydropsyche			1

Fishing River #3 (continued): Spring 2003

Oecetis	2		
Planariidae		11	
Aulodrilus	3		
Branchiura sowerbyi	2	2	
Enchytraeidae			1
Limnodrilus cervix	10	1	
Limnodrilus hoffmeisteri	6	5	
Tubificidae	21	13	1
Sphaeriidae	6	5	

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Fishing River #4: Spring 2003

Taxa	NF	RM	SG
Acarina	1	1	
Hyalella azteca		2	13
Berosus		1	
Dubiraphia	6	7	1
Oreodytes	2		
Scirtes		7	
Stenelmis	2		
Ablabesmyia	4		4
Ceratopogoninae	3	1	
Chironomus	8		
Cladotanytarsus	7	1	2
Corynoneura		1	
Cricotopus bicinctus		1	1
Cricotopus/Orthocladius		7	5
Cryptochironomus	3		2
Cryptotendipes	2		
Dicrotendipes	11	15	97
Diptera	6		
Glyptotendipes	3	9	98
Hydrobaenus	10	10	9
Labrundinia		2	
Limonia			1
Nanocladius			1
Odontomyia		1	
Paraphaenocladius		3	
Paratanytarsus	2		1
Polypedilum convictum grp			1
Polypedilum fallax grp			1
Polypedilum halterale grp	60		
Polypedilum illinoense grp		157	4
Polypedilum scalaenum grp			1
Procladius	50	2	2
Pseudochironomus			1
Stictochironomus	21		
Tanytarsus	4	2	7
Thienemannimyia grp.		2	9
Caenis latipennis	67	5	6
Hexagenia	1		
Stenacron			1
Belostoma		-99	
Pelocoris		-99	
Trichocorixa	20		
Ancylidae	1	4	
Fossaria	3	22	

Fishing River #4 (continued): Spring 2003

Physella	6	15	3
Lumbricidae	1		
Argia		1	2
Enallagma		4	1
Macromia	-99		
Oecetis	4		
Planariidae	1		
Aulodrilus	3		
Branchiura sowerbyi	5		
Ilyodrilus templetoni	2		
Limnodrilus cervix	3		
Limnodrilus claparedianus	1		
Limnodrilus hoffmeisteri	2		
Tubificidae	18	1	2
Sphaeriidae	11	3	2

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Clear Creek #1a: Spring 2003

Taxa	NF	RM	SG
Chordodidae			1
Acarina			7
Hyalella azteca		5	
Dubiraphia	3	18	2
Helichus lithophilus		6	
Macronychus glabratus		7	2
Oreodytes		11	
Scirtes		2	
Stenelmis	1		
Ablabesmyia		13	1
Ceratopogoninae	125	23	18
Chironomus	1		1
Chrysops			1
Cladotanytarsus		2	16
Cricotopus/Orthocladius	10	11	51
Cryptochironomus	1		1
Cryptotendipes	1		1
Dicrotendipes	1	46	37
Diplocladius		1	3
Diptera	1	1	
Glyptotendipes		186	38
Gonomyia	1		
Hydrobaenus	5	8	20
Labrundinia		1	
Nanocladius			1
Nilothauma		3	1
Ormosia	1		
Parachironomus		1	
Paralauterborniella	1	1	3
Paraphaenocladius	2		1
Paratanytarsus		5	
Paratendipes	2		
Phaenopsectra			2
Pilaria	1		
Polypedilum fallax grp			1
Polypedilum halterale grp	23	1	13
Polypedilum illinoense grp			1
Polypedilum scalaenum grp	5	4	18
Procladius	3		3
Stenochironomus			1
Stictochironomus	2		1
Tabanus	1		
Tanytarsus	2	13	13
Thienemannimyia grp.		27	9

Clear Creek #1a (continued): Spring 2003

Tipula		-99	
Caenis latipennis	5	12	10
Callibaetis		1	
Hexagenia limbata	7		2
Leptophlebia		-99	-99
Corixidae			1
Neoplea		1	
Ranatra nigra		-99	
Trichocorixa	3		
Petrophila		1	
Ancylidae		1	
Fossaria		3	4
Physella	-99	34	10
Lumbricidae		1	
Sialis		-99	
Argia		20	1
Enallagma		5	
Gomphus	1		
Nasiaeschna pentacantha		1	
Plathemis	1		
Cheumatopsyche		1	-99
Nectopsyche		9	2
Nyctiophylax		-99	
Aulodrilus	1		
Branchiura sowerbyi	1		
Enchytraeidae	1		
Ilyodrilus templetoni	2		
Limnodrilus cervix	12		
Limnodrilus claparedianus	4		1
Limnodrilus hoffmeisteri	11		2
Tubificidae	61		2
Pisidium	7		
Sphaerium	2	10	5

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Clear Creek #1b: Spring 2003

Taxa	NF	RM	SG
Acarina	1		
Hyalella azteca		9	2
Dubiraphia	12	19	4
Helichus lithophilus		5	4
Macronychus glabratus		5	
Oreodytes		4	-99
Stenelmis		1	
Ablabesmyia	2	5	
Ceratopogoninae	144	3	28
Chironomus	2		
Cladotanytarsus	4		12
Cricotopus/Orthocladius	2	1	73
Cryptochironomus	2		
Cryptotendipes	8	1	2
Dicrotendipes	2	16	19
Diplocladius			1
Diptera	3	5	1
Glyptotendipes		66	30
Hydrobaenus	4		14
Labrundinia		1	
Paralauterborniella	4		3
Paratanytarsus		7	
Pilaria			1
Polypedilum fallax grp			3
Polypedilum halterale grp	27		12
Polypedilum illinoense grp		3	
Polypedilum scalaenum grp	13	1	9
Procladius	5		
Rheotanytarsus			1
Stenochironomus			2
Stictochironomus	2		
Tanytarsus	3	37	14
Thienemannimyia grp.		29	15
Tribelos			1
Caenis latipennis	9	18	11
Hexagenia limbata	2	1	-99
Leptophlebia		1	
Corixidae	1		
Fossaria	1		8
Physella	-99		9
Sialis		-99	
Argia		34	
Enallagma		5	
Gomphus		-99	

Clear Creek #1b (continued): Spring 2003

Macromia		-99	
Chloroperlidae			2
Cheumatopsyche			1
Oecetis	2		
Triaenodes		14	
Aulodrilus	2		
Enchytraeidae	1		
Ilyodrilus templetoni	6	1	
Limnodrilus cervix	11		1
Limnodrilus hoffmeisteri	16		
Tubificidae	33	5	3
Pisidium	1		
Sphaeriidae	-99	2	7

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Clear Creek #3: Spring 2003

Taxa	NF	RM	SG
Acarina		2	
Crangonyx		1	
Agabus	1		1
Coleoptera	1		
Dubiraphia	2	8	
Helichus lithophilus		2	
Hydroporus	2	2	
Oreodytes			1
Scirtes	1		1
Tropisternus	1		
Ablabesmyia		1	1
Ceratopogoninae	23	1	12
Chironomus	5		
Cladotanytarsus	6		11
Cricotopus/Orthocladius	2	1	27
Dasyheleinae			1
Dicrotendipes		3	12
Diptera	23		1
Glyptotendipes		5	
Gonomyia	1		
Hydrobaenus	23	3	121
Ormosia	1		
Parakiefferiella		1	
Paraphaenocladius	2		3
Paratanytarsus	1	11	
Paratendipes			1
Pericoma	1		2
Polypedilum halterale grp	11		3
Polypedilum illinoense grp			1
Stictochironomus	34		
Tanytarsus	3	2	4
Caenis latipennis	21	173	7
Microvelia		7	
Trichocorixa	2	2	2
Ferrissia	3	53	
Fossaria	47	9	29
Laevapex	1	1	2
Physella	15	15	15
Dromogomphus		-99	
Epitheca (Epicordulia)		1	
Pachydiplax longipennis		-99	
Glossiphoniidae		-99	
Oecetis		1	
Triaenodes		2	

Clear Creek #3: Spring 2003

Aulodrilus	1	5	
Enchytraeidae	6	4	
Limnodrilus claparedianus	4		
Limnodrilus hoffmeisteri	11	1	
Tubificidae	17	8	1
Pisidium	1		2
Sphaeriidae	19	1	4

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Muddy Fork #1: Spring 2003

Taxa	NF	RM	SG
Acarina	2		3
Hyalella azteca		2	3
Dubiraphia	20	53	1
Helichus lithophilus		8	1
Macronychus glabratus		1	2
Oreodytes	6	22	2
Peltodytes		1	
Scirtes		1	
Ablabesmyia	10	9	4
Ceratopogoninae	15	1	7
Chironomus	8		1
Cladotanytarsus	3	3	4
Cricotopus/Orthocladius	2	2	15
Cryptochironomus	1		
Cryptotendipes	6		2
Dasyheleinae			3
Dicrotendipes	14	11	65
Diptera			5
Glyptotendipes		2	9
Hydrobaenus	5	3	5
Labrundinia	1	3	3
Nanocladius		1	3
Nilothauma		1	1
Parakiefferiella		1	2
Paraphaenocladius		4	
Paratanytarsus		13	2
Phaenopsectra		1	3
Polypedilum convictum grp			1
Polypedilum halterale grp	8	1	4
Polypedilum illinoense grp	2	35	6
Polypedilum scalaenum grp			4
Procladius	12	4	1
Pseudochironomus	1		5
Stictochironomus	9		1
Tabanus	1	2	
Tanypus	6	2	
Tanytarsus	30	24	27
Thienemannimyia grp.		3	2
Tipula		1	
Zavrelimyia		2	
Caenis latipennis	62	21	15
Hexagenia limbata	11	-99	1
Leptophlebia		-99	
Stenacron			2

Muddy Fork #1 (continued): Spring 2003

Stenonema femoratum			1
Gerris		1	
Microvelia		2	
Ancylidae	1	3	1
Fossaria	7	25	
Helisoma			-99
Physella	10	21	
Lumbricidae	1		
Argia		5	1
Enallagma	1	1	1
Gomphus	-99		
Macromia		-99	
Progomphus obscurus	-99		
Nyctiophylax			2
Oecetis	2	2	3
Triaenodes		1	
Aulodrilus	3		
Branchiura sowerbyi	1		
Limnodrilus claparedianus	2		
Limnodrilus hoffmeisteri	7	3	
Tubificidae	15	6	
Unionidae	-99		
Sphaeriidae	9	4	3

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Muddy Fork #2: Spring 2003

Taxa	NF	RM	SG
Acarina	17		1
Hyalella azteca		1	12
Berosus			1
Dubiraphia	3	8	3
Helichus lithophilus			1
Hydroporus			1
Oreodytes	17		5
Peltodytes	1		
Scirtes		3	
Stenelmis		4	
Ablabesmyia	3		13
Ceratopogoninae	69		6
Chironomus	13		
Cladotanytarsus	2		8
Cricotopus/Orthocladius	19	2	3
Cryptochironomus	4		
Cryptotendipes	5		
Dicrotendipes	12	3	46
Glyptotendipes	8	5	29
Gonomyia	6	1	1
Hydrobaenus	12	3	12
Natarsia	1		
Nilothauma			1
Parakiefferiella	1		2
Paraphaenocladius	2		2
Paratanytarsus			1
Polypedilum halterale grp	12		1
Polypedilum illinoense grp	1	4	11
Polypedilum scalaenum grp	3		
Procladius	16	1	1
Pseudochironomus			11
Stictochironomus	3		
Tabanus		2	1
Tanytarsus	4		12
Thienemannimyia grp.			1
Zavrelimyia			1
Caenis latipennis	17		28
Stenonema femoratum			1
Pyralidae	1		
Ancylidae	6	1	1
Fossaria	10	4	18
Physella	5	2	6
Argia			1
Hydroptila	2		

Muddy Fork #2 (continued): Spring 2003

Oecetis	2		
Oxyethira	1		
Enchytraeidae	2		
Limnodrilus hoffmeisteri	1	5	
Tubificidae	6		
Sphaeriidae	4	1	6

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Carroll Creek #1: Spring 2003

Taxa	NF	RM	SG
Acarina			6
Hyalella azteca		2	8
Berosus			8
Dubiraphia	5	1	2
Gyrinus		2	
Helichus lithophilus			1
Scirtes		1	1
Stenelmis	3		
Ablabesmyia	3		
Ceratopogoninae	26		9
Chironomus	10		
Cladotanytarsus	1		6
Clinotanypus	1		
Cricotopus/Orthocladius	7	5	12
Cryptochironomus	6		
Cryptotendipes	8		
Dasyheleinae			1
Dicrotendipes	9	9	64
Diptera	6	1	1
Glyptotendipes	11	5	27
Gonomyia			5
Hydrobaenus	15	6	19
Nilothauma			1
Paraphaenocladius	1	2	1
Polypedilum halterale grp	5		3
Polypedilum illinoense grp			1
Polypedilum scalaenum grp	3		3
Procladius	22	4	3
Stenochironomus			9
Stictochironomus	17	1	4
Tabanus	2	1	2
Tanypus	1		
Tanytarsus	10		13
Tipula	1	1	
Zavrelimyia	1		
Caenis latipennis	14	4	25
Hexagenia limbata	9		1
Microvelia		3	
Trichocorixa		1	1
Caecidotea		4	
Pyralidae	1		
Fossaria	1		44
Physella	3		9
Lumbricidae	2		

Carroll Creek #1 (continued): Spring 2003

Calopterygidae			1
Libellula		1	
Progomphus obscurus	1		
Chloroperlidae	1		1
Ironoquia		1	
Aulodrilus	1		
Branchiura sowerbyi	3	1	
Enchytraeidae	2		1
Limnodrilus cervix	11		
Limnodrilus claparedianus	3	1	
Limnodrilus hoffmeisteri	7	1	1
Tubificidae	45	2	4
Unionidae	3		
Pisidium	1	1	
Sphaeriidae	1	1	27

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Carroll Creek #2: Spring 2003

Taxa	NF	RM	SG
Acarina	1	11	2
Crangonyx		3	
Hyalella azteca		3	4
Erpobdellidae		-99	
Agabus		1	
Berosus	5		4
Desmopachria		1	
Dubiraphia	1	7	
Hydroporus		1	
Scirtes		17	
Tropisternus		-99	-99
Ablabesmyia			1
Ceratopogoninae	14	1	
Chironomus	7	1	
Cricotopus/Orthocladius	8	11	
Cryptotendipes	2		
Dicrotendipes	3	5	36
Diptera		1	2
Glyptotendipes	5	28	124
Hydrobaenus	68	59	3
Microchironomus	2		
Odontomyia		1	
Paratanytarsus	1		
Pilaria		1	
Polypedilum halterale grp	16		
Procladius	15		
Tanytarsus	3		3
Caenis latipennis	2	11	1
Stenacron			1
Microvelia		12	
Trichocorixa	1	5	
Ferrissia	2		1
Fossaria	22	17	57
Gyraulus	2	14	3
Helisoma	-99	-99	1
Physella	9	37	7
Dromogomphus		-99	
Enallagma		1	
Ischnura		1	
Libellula		-99	
Nasiaeschna pentacantha			1
Allocapnia		4	
Helicopsyche			2
Ironoquia		1	

Carroll Creek #2 (continued): Spring 2003

Aulodrilus	1		
Branchiura sowerbyi	14		
Enchytraeidae		10	
Limnodrilus claparedianus	1		
Limnodrilus hoffmeisteri	11	2	
Tubificidae	57	10	
Pisidium	6	3	
Sphaeriidae	39	25	2

NF = Non-flow Habitat
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-99 = Present in Samples

Williams Creek #1: Spring 2003

Taxa	NF	RM	SG
Acarina		2	
Hyalella azteca			1
Erpobdellidae	-99	1	
Dubiraphia	16	30	13
Helichus lithophilus		1	
Peltodytes		2	
Scirtes		1	
Stenelmis		1	
Palaemonetes kadiakensis		3	-99
Ablabesmyia		1	2
Ceratopogoninae	24	4	8
Chironomus	12		10
Clinotanypus	1		
Cricotopus/Orthocladius	2	13	8
Cryptochironomus			1
Cryptotendipes	3		
Dicrotendipes	3	27	74
Glyptotendipes	2	20	41
Hydrobaenus	9	16	10
Labrundinia		1	
Larsia			1
Paralauterborniella	7	1	4
Paraphaenocladius		1	1
Paratanytarsus		14	4
Phaenopsectra		10	2
Polypedilum fallax grp		2	8
Polypedilum halterale grp	7	2	2
Polypedilum illinoense grp		8	2
Polypedilum scalaenum grp		1	
Procladius	23	4	6
Rheocricotopus			1
Stenochironomus			4
Tanypus		2	
Tanytarsus		1	1
Thienemannimyia grp.	1	9	8
Zavrelimyia		1	
Caenis latipennis	2	6	
Stenacron		2	4
Corixidae		3	
Trichocorixa	3		
Ancylidae	1	1	1
Fossaria		8	4
Helisoma		1	
Physella	3	119	40

Williams Creek #1 (continued): Spring 2003

Sialis	-99	1	
Argia		4	
Calopteryx		2	
Enallagma		3	
Gomphus	-99		1
Nasiaeschna pentacantha			-99
Oecetis		2	
Branchiura sowerbyi	10	4	
Enchytraeidae	1		3
Ilyodrilus templetoni	12		
Limnodrilus cervix	7	1	
Limnodrilus claparedianus	3		
Limnodrilus hoffmeisteri	1	8	5
Tubificidae	27	7	4
Unionidae	-99		
Pisidium	3	6	
Sphaeriidae	51	16	4
Sphaerium	2	2	1

Williams Creek #2: Spring 2003

Taxa	NF	RM	SG
Acarina	1	3	
Crangonyx		1	
Hyalella azteca		1	1
Dubiraphia	1	27	3
Helichus lithophilus		2	
Hydroporus		3	12
Scirtes		5	
Ablabesmyia		1	
Ceratopogoninae	12		
Chironomus	6		
Cladotanytarsus	2	1	
Cricotopus/Orthocladius	8	8	13
Dicrotendipes	51	27	120
Diptera	4	1	
Eukiefferiella	1		1
Glyptotendipes	2	1	20
Hydrobaenus	22	6	25
Microtendipes		1	
Parakiefferiella			1
Paralauterborniella		1	
Paraphaenocladius	1		
Paratanytarsus	4	8	1
Phaenopsectra		5	6
Polypedilum fallax grp			4
Polypedilum illinoense grp		1	1
Polypedilum scalaenum grp	1		
Procladius			2
Pseudochironomus		1	
Stenochironomus			3
Stictochironomus	3		1
Tanytarsus	23	6	11
Thienemannimyia grp.	1	1	3
Caenis latipennis	45	5	27
Stenonema femoratum			1
Microvelia		3	
Ancylidae	6		11
Fossaria	13	41	26
Physella	6	7	
Chauliodes pectinicornis		-99	
Calopteryx			1
Nasiaeschna pentacantha		2	
Allocapnia		2	
Oecetis	1		2
Planariidae			1

Williams Creek #2 (continued): Spring 2003

Branchiura sowerbyi	8	2	
Enchytraeidae			1
Ilyodrilus templetoni		5	
Limnodrilus claparedianus	2		
Limnodrilus hoffmeisteri	2	6	
Tubificidae	24	17	
Pisidium	1		2
Sphaeriidae	3	2	2
Sphaerium	2		-99

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East Fork Fishing River #1: Spring 2003

Taxa	NF	RM	SG
Acarina	1	3	
Erpobdellidae	-99	-99	
Agabus		1	
Dineutus		1	
Dubiraphia	6	6	5
Gyrinus		1	
Helichus		-99	
Helichus lithophilus		5	
Hydrochus		2	
Hydroporus		1	
Oreodytes		2	
Peltodytes	1		
Scirtes		1	
Palaemonetes kadiakensis		2	
Ceratopogoninae	8		3
Chaoborus	2		
Chironomus	8		2
Clinotanypus	4		
Cricotopus/Orthocladius	5	22	31
Dicrotendipes	10	22	50
Diptera			1
Glyptotendipes	9	64	93
Hydrobaenus	4	2	16
Paraphaenocladius		1	
Paratanytarsus	4	4	2
Phaenopsectra			1
Pilaria		2	
Polypedilum fallax grp			1
Polypedilum halterale grp	8		
Polypedilum illinoense grp		2	
Polypedilum scalaenum grp			1
Procladius	38	8	12
Tanypus	3		
Tanytarsus			1
Thienemannimyia grp.		16	27
Caenis latipennis	2	4	2
Leptophlebia	1		
Corixidae	2		
Microvelia		1	
Caecidotea		6	
Ancylidae	3	2	5
Fossaria	1	8	6
Menetus		2	1
Physella	5	20	7

East Fork Fishing River #1 (continued): Spring 2003

Sialis	-99		
Argia		1	
Basiaeschna janata		3	
Enallagma		1	
Glossiphoniidae	-99		
Aulodrilus	69		
Branchiura sowerbyi	1	1	
Enchytraeidae		2	
Limnodrilus cervix	3	1	
Limnodrilus claparedianus	1		
Limnodrilus hoffmeisteri	3	5	
Quistradrilus multisetosus	44	17	3
Tubificidae	62	23	1
Corbicula	3	1	1
Sphaeriidae	16	6	13

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East Fork Fishing River #2: Spring 2003

Taxa	NF	RM	SG
Acarina	7	19	19
Hyalella azteca	-99	45	29
Erpobdellidae	-99		
Dubiraphia	5	10	2
Oreodytes	6	9	6
Stenelmis	3	29	
Orconectes virilis		-99	
Ablabesmyia		2	2
Ceratopogoninae	120	1	3
Chironomus	8	4	25
Clinotanypus	1	1	
Corynoneura	1	4	
Cricotopus/Orthocladius	5	5	4
Cryptotendipes	2		1
Dasyheleinae			2
Dicrotendipes	5	10	19
Glyptotendipes		2	7
Hydrobaenus	4	7	5
Labrundinia			1
Microtendipes		1	1
Natarsia	2	1	
Nilothauma		2	
Parakiefferiella		7	
Paraphaenocladius		1	
Paratanytarsus		1	1
Paratendipes	4		
Phaenopsectra	1	3	
Polypedilum convictum grp	1		
Polypedilum illinoense grp	1	3	5
Polypedilum scalaenum grp	3	1	
Procladius	3		3
Pseudochironomus	1		
Stictochironomus	10		
Tanypus	16		1
Tanytarsus	4	8	5
Thienemanniella		1	
Thienemannimyia grp.	3	10	1
Zavrelimyia	1	1	
Caenis latipennis	8	19	13
Centroptilum	1		
Hexagenia	1		
Stenonema femoratum	1	2	
Microvelia	1	4	
Ancylidae		2	

East Fork Fishing River #2 (continued): Spring 2003

Fossaria	2	5	4
Menetus	6	8	10
Physella		7	7
Lumbricidae	2		
Basiaeschna janata		1	
Calopteryx		2	
Enallagma		5	
Erythemis		1	
Gomphus		-99	
Libellula		1	
Macromia		1	
Helicopsyche			2
Ironoquia		1	
Nyctiophylax			1
Oecetis	1	2	1
Planariidae	1	1	
Branchiura sowerbyi	4	5	
Limnodrilus hoffmeisteri	3	1	20
Tubificidae	16	11	39
Sphaeriidae	16	8	4

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Holmes Creek #1: Spring 2003

Taxa	NF	RM	SG
Acarina			1
Hyalella azteca			5
Dubiraphia	3	16	8
Enochrus			1
Helichus lithophilus		2	1
Hydroporus		1	
Oreodytes	1	3	1
Scirtes		7	11
Stenelmis			1
Ablabesmyia	1	3	7
Allognosta	1		
Ceratopogoninae	8		12
Chironomus	1	1	1
Cladotanytarsus	2	1	2
Corynoneura		1	
Cricotopus/Orthocladius	9	27	9
Cryptochironomus	1		4
Dicrotendipes	6	39	55
Diptera	5		1
Endochironomus		1	
Glyptotendipes		11	13
Hydrobaenus	20	22	11
Kiefferulus			3
Labrundinia	1		
Microtendipes			1
Nanocladius		1	
Paralauterborniella	5		3
Paraphaenocladius	1	1	
Paratanytarsus	9	82	15
Paratendipes	1		1
Phaenopsectra	2	4	16
Polypedilum convictum grp	2	1	
Polypedilum fallax grp			4
Polypedilum halterale grp	3		
Polypedilum illinoense grp	2	27	7
Procladius	8	2	1
Tabanus		-99	
Tanypus			1
Tanytarsus	26	10	21
Thienemannimyia grp.	1	7	10
Caenis latipennis	7	6	14
Heptageniidae	1		
Hexagenia limbata	2		
Stenacron			2

Holmes Creek #1 (continued): Spring 2003

Trichocorixa	3	2	
Ancylidae		1	-99
Fossaria			3
Physella	5	1	3
Lumbricidae	7		
Argia	3	5	2
Enallagma	2	3	
Hetaerina		1	1
Nasiaeschna pentacantha		-99	1
Cheumatopsyche	1		
Aulodrilus	6		
Branchiura sowerbyi	1		
Enchytraeidae		2	2
Limnodrilus cervix	7		1
Limnodrilus claparedianus	8		
Limnodrilus hoffmeisteri	12		3
Tubificidae	75		15
Pisidium	1		
Sphaeriidae	1		2

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